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EVOLUTION OF THE GERM-PLASM[1]

By Professor C. E. McCLUNG

EMERITUS PROFESSOR OF ZOOLOGY, UNIVERSITY OF PENNSYLVANIA; VISITING PROFESSOR OF ZOOLOGY, UNIVERSITY OF ILLINOIS

A definition of terms seems to be the first requisite in a discussion of this subject. By "germ-plasm" we mean a distinctive substance, endowed with all the properties of life, but especially with that of reproduction, which here is, in some measure, unique. Equivalence is an inherent characteristic of organic reproduction, and it holds in respect to the germ-plasm itself; but, whereas commonly the influence of a part is continuously the same, that of the germ-plasm is cyclically different. It involves elements which mark the race and so it may be denominated "racial material." It is customary to distinguish between "germ-plasm" and "soma-plasm," both being nuclear, one concerned with racial processes, the other with those of the individual. This distinction is, however, purely arbitrary and may lead to misunderstandings. Such a distinction was suggested by the presumed functional differences between the macro- and micronuclei of certain Protozoa. But if the germ-plasm is defined specifically as "that substance, or organization, which distinguishes a chromosome complex" then it is essentially the same in both germ and somatic cells. Mere observations tell us that the chromosome complement of germ and somatic cells is one, both being derived by direct descent from that of the original zygote. Finally, and in a more abstract sense, the germ-plasm may be defined as "the temporal record of racial experience." However conceived, it has the properties of continuity, specificity and control of organic processes.

[1] Presented at the University of Pennsylvania Bicentennial Conference, September, 1940.

The term "evolution" signifies a process characterized by progressive, continuous and related change, as opposed to one in which sudden, discontinuous or unrelated modifications occur. Broadly conceived, it includes not only the stages of full functioning but also the ones which may be characterized as formative. The germ-plasm did not always exist. Only when the earth reached a certain balance in temperature, moisture, radiation and other physico-chemical conditions was life possible. Organic evolution is therefore clearly a part of cosmic evolution. All the evidence in our possession indicates that the first organic entities were small and relatively simple. Since probably the most significant attribute of life is that it exists only in unit form, our search for the beginning of organic things leads us necessarily to the conception of minute, simple units. That these may still occur as separate and independent bodies is suggested by the existence of such related organizations as the filterable viruses; that they persist as parts of coordinated aggregates follows from our conception of genes. The simplest of known organisms is relatively so complex that we can not conceive it as coming into existence fully formed. We must believe that it is the result of a gradual development from small and simple beginnings, which, by assumption, had the properties of life in essence. Therefore these were units in a continuous series, perpetuated by the inherent power of reproduction. The only continuous living thing we know is the germ-plasm, and we naturally associate it with these early beginnings. Thus conceived, the germ-plasm of an existing animal has within it the direct descendants of successively added units, which have arisen in response to altered conditions, both within and without a series of organisms. Unit organization, perpetuated in a continuous series, addition of new elements in response to changed conditions, incorporation of these into a coordinated union of higher complexity, and finally the formation of the very complex structure we call a cell summarizes the series of events as we must now conceive them. In turn cells became aggregated into coordinated bodies of almost infinite complexity and variety. Originally the germ-plasm was, according to this view, in immediate relation with the environment. Gradually it was removed further and further from this physical contact until now only such agents as radiations may touch it directly. From the very first stage of its existence the germ-plasm has been directive in its relations. At first simple and applied directly to the materials and conditions of the environment, its influence has become more and more complex, involved and remote from the operations of the organism, particularly in the germ cells. Even further than we have thought, this is true also of the somatic cells. During development more and more coordinating mechanisms, neural and humoral, are formed until finally it would seem that, for the nuclear materials, there remain only a few of the most basic functions. Each type of cell becomes highly specialized through modification of its cytosome, while its nucleus may lose its reproductive power or even disappear completely. For the individual there is then an exaltation of the cytosomic elements and a limitation of the nuclear. Only in the germ cells are nuclear potentialities retained. Retention of this power by the germ cells is made certain by various isolation devices which remove them from participation in differentiation during development.

But since the race is only a succession of individuals how can we differentiate between activities which serve only the single individual and those which concern the group? Naturally, this distinction can not be closely drawn, and, in fact, it is largely temporal. A germ cell of one individual generation, isolated from somatic participation, becomes detached and forms a complete organism of the next generation. By some insulating device the germinal elements within the gonad do not participate in somatic processes, but merely perpetuate themselves. On being removed from this inhibition they are free from the limited rôle of mere germ cells and may perform, through their descendants, all somatic activities. The germ-plasm, the record of experiences to be repeated, is contained in all cells—in somatically included germ cells, there inhibited from full expression; in differentiated somatic cells, limited largely to a single expression; and is completely lost only in cells about to disappear. Distinctions between germ and somatic cells, unless early established by some marked change, as in Ascaris, may therefore be gradually established by specific limitations within somatic cells and by the retention of unaltered capacities in the germ cells. Fixation and limitation of function, it is assumed, is due to changes within the racial material through repeated reactions with a specialized cytosome.

But how are we to gain any practical knowledge of such changes as occur during differentiation and development? Surely only by a comprehensive and detailed study of the germinal material during these stages. Here we note that there is a general pattern in all Metazoa, which at once suggests a basic unity of design and function; also that there are characteristic group modifications of such a character as to indicate that this is progressively increased in complexity in the phylogenetic series. Cytogenetic studies have demonstrated that the germ-plasm is a precise organization of particulate, causal elements which are specific in nature and yet general in their attributes. Which is perhaps to say that of a common series of

functions, they show, individually, emphasis upon certain ones of these. Such studies have, however, yielded no knowledge of the method by which these causal elements operate. By limited and experimental investigations it may be possible to learn the individual operation of this mechanism, but knowledge of its phylogenetic development can come only from a careful comparison of its expressions in a group of organisms. But for this there is first required a careful analysis of the fundamental relations of organisms so that it is possible to evaluate the differences which characterize groups.

Every organism is a fully developed and coordinated unit. In this measure all organisms are alike. At the same time they differ, even individually. In estimating phylogenetic relationships what relative values have these elements of likeness and unlikeness? Since organisms are completely specific, structurally and functionally, at every stage of development, these qualities must exist even in the one-cell stage. When therefore we seek to discover, in the causal mechanism of the chromosomes, differential conditions between taxonomic groups, what shall we look for? Obviously from the considerations just stated, great differences can not obtain. We see indeed that they do not. Except for the lowest forms all organisms are composed of cells, and these are of a limited number of kinds wherever found. For each distinctive function there is a common form of appropriate cell. The visible difference between members of these types is in no way commensurate with the phylogenetic standing of the organisms in which they are found. High development and perfect coordination of structure and function occur at every taxonomic level. Since, then, individual structural units, as such, are no measure of phylogenetic advance, we must seek elsewhere for a criterion, and the course of individual development offers suggestions. There we witness, in addition to the differentiation of cell types, two suggestive phenomena, *i.e.,* increase in the number of elements, and second in their interrelations, which mean greater complexity.

Such a situation carries with it the need for more extensive and perfect measures of control and correlation. This coordination is primarily provided by the nervous system; therefore in higher forms there is a more extensive development of this system. However, for purposes of regulating internal functioning, this control system does not anywhere differ widely. It is only when the level of ideation and reason is reached that a new problem presents itself, and we have to inquire whether human nerve cells develop new attributes, or whether higher functioning results from increased and bettered interrelations between them. Practically that is not a problem for those who seek an explanation of the relation between the causal mechanism of cells and developmental processes, for these do not immediately involve the subsequent phenomena of ideation. Our problem may accordingly be stated thus: In the presence of a vast series of structurally different types of organisms, all performing a common series of functions, where shall we look in the causal mechanism of the cells for evidences of the required differences? Practically put—does increased complexity of structure in the phylogenetic series, as in individual development, involve more elements as well as increased extent of interrelationships between them? If, as seems apparent, each gene, representing a discrete unit of the determinative mechanism, corresponds to the incidence of some recognizable character in the completed organism, then it would logically follow that more characters mean more genes. This is probably a correct inference, in general terms, but at the same time we have to recognize the possibility of another alternative. If, as is certainly true, each form of organism is completely functional, then it possesses all the needed properties of an organism. All that can happen toward progress is a refinement in the operation of these universal functions. Refinement, we find, commonly involves increased complexity in the mechanism which performs organic functions. Therefore apparently entirely new structures are only altered expressions of previously existing mechanisms. For instance, devices for producing motion in Metazoa consist, usually, of contractile elements attached to skeletal members. Motion results when muscles contract and force the skeletal structures to react against the opposing medium. Depending upon whether this medium is air, water or a solid substratum, appropriate mechanisms develop. In different cases if the same structural elements are involved we speak of "homologues"; if a similar device in form involves different structural elements we refer to them as "analogues." When only the contractile element is involved, greater diversity comes in, and this is further intensified when the usual paired members are replaced by a single median one. In view of the almost infinite range of motor mechanisms developed by organisms, it does not seem possible that they could result from the permutations of a common series of controls in the developing whole. At the same time when we recall that, simple or complex, they are each the result of an infinite number of repeated reactions between organisms and a given environmental requirement, the possibility of multiple modifications of a basic system must be considered.

Perhaps the problem might be stated specifically in this way: Since all organisms exhibit a common series of functions, and since functions are performed under the control of a recognizable series of agents within the chromosomes, there must exist a nuclear mecha-

nism common to all organic types. Logically, this would follow, and observation tells us that, at least in its major features, such a situation does exist, for cellular structure and behavior are essentially the same wherever found. Moreover, in the earlier and relatively simpler processes of development, strong likenesses prevail through all forms. But beyond this, what are we to expect? Does each advance in complexity, each new structural element mean additional gene controls or are they due to what might be called the better education of members of an existing system through new experiences? When it appeared that each character was due to the influence of a particular control there could be but one answer to this question, but now that it is known that each structure results from the operation of the entire integrated system, in which genes are merely differentiators, producing successively different results as development proceeds, then the picture is not so clear and simple. There must also be considered the facts that the cellular mechanism is always much the same, the number and size of the chromosomes are independent of phylogenetic stages, that different results follow upon changes of position of the genes in the series, and that probably the result of gene action varies with the time of its incidence. All these considerations emphasize the need for a most careful study of all elements of the problem. Present knowledge would suggest, certainly, the existence of a basic and prevalent causal mechanism and at the same time the probability of the addition of new members in response to the demands of new conditions. Since, however, each gene modifies the action of the whole system, and therefore produces many effects, an equal number of additional elements would not seem to be required. The course of evolution indicates that any change, to become established, requires innumerable embodiments and great periods of time. Above all things it appears that any successful change must be completely conformable to conditions within the system and also to those in the environment. The participation of chance or accident is strictly excluded. It is true that biparental reproduction intrinsically implies variation, but this is always within definite limits and concerns the permutations of existing elements rather than the addition of new ones.

These considerations are of a very practical character when programs of study are concerned. It is a truism that we see what we are looking for, and this is particularly so of microscopical studies. Therefore, as students of cytogenetics we are much concerned to know whether we should seek additions to the chromosome mechanism or whether we should turn our attention toward the detection of modification within a prevailing type. For many years my students and myself have concentrated our studies upon the conditions found in the germ cells of one family of insects—the Acrididae—seeking to establish the relationships existing between observable changes in the structure and behavior of chromosomes and the associated body characters. Many of these have been noted and found to be constant under given conditions. They involve varied features of chromosome structure, behavior and relations, but represent, not additions of new things, but modifications in a persistent system. They involve such matters as differences in chromosome associations and in fiber attachment, variations in relative time of extension and concentration of individual chromosomes, forms and sizes of chromosomes, relations to chromomere vesicles, etc.

This Orthopteran family is a distinctive group, with clear and sharply marked characters. Such variations of form as exist in subfamilies, genera and species are due to modifications of proportions and relations of the members of the family complex of characters. Logically, therefore, there would not be expected in the control mechanism of development any marked changes or any additions, and these are not found. The picture here is entirely consistent with our present assumptions in cytogenetics. It is a question, however, as to what might be found in comparing the conditions in this limited and well-defined animal group with others of very diverse nature. Without any guiding principle to indicate the best method of investigation, it has seemed wisest to learn as definitely and fully as possible what we can of the modifications shown in one organic group. After enough correlations between taxonomic characters and germ-cell structure have been studied, there will doubtless emerge the outlines of some principle underlying all the observed conditions, and eventually this will become generally applicable. However difficult such studies of broad comparative character may be, they are absolutely essential to an understanding of the true nature of living processes. No amount of pseudo-philosophical speculation, based upon hasty and imperfect studies, can take their place.

We are certain of the continuity of the germ-plasm and of its general nature as the material record of racial experiences. It seems evident that the hope for an understanding of racial and individual development waits upon a fuller knowledge of the nature and behavior of the visible elements which embody the germ-plasm; and upon the inferences concerning the activities of the ultimate conceptual units revealed by genetical and embryological studies. Only long, continued, systematic, comparative, cytological studies can provide the needed information. A continuation of the exceedingly fruitful cooperation between cytologists and geneticists, which has marked the years of the present century, will, in time, inform us of the intimate nature of the germ-plasm.

THE ZOOLOGICAL SOCIETY IN THESE TIMES[1]

By FAIRFIELD OSBORN

PRESIDENT OF THE NEW YORK ZOOLOGICAL SOCIETY

IT is during the days of confusion and crisis in human affairs—not in the days of tranquility—that the value of any public institution can best be determined. "Measure one's strength in the hours of storm, not in the lull of a summer's noon."

It is therefore extraordinarily gratifying to report that, for the Zoological Society, the year 1940 was one of unusual progress and development. I take this as a symbol. It is no accident. It is affirmation of the fact that the Society, through the two great institutions under its management, through its scientific work, through its educational activities, is providing the public not only with things in which people find enjoyment or recreation—but with influences that must become more and more a part of people's conceptions of life as a whole. Man, to his own distress, is obscuring many of the truths which affect all life—including his own. Expressed in its broadest terms, the Zoological Society exists in order to tell people the story and meaning of life on this earth as expressed through the myriad and varied forms of living creatures. It is a symphony of vast and powerful undertones—millenniums of time, evolutionary changes, adaptations to environment. It is, at the same time, a symphony of overtones—of beauty, of strangeness, of gayety—even of humor. Some day, if our plans and visions may be realized, the words "zoo" and "aquarium" will attain a broader significance, one which to-day we can but dimly be aware of.

We are proceeding on the principle that while the present vast preparations of the nation to cope with world conditions are paramount, it is, at the same time, necessary—in a sense more necessary than in normal times—to carry forward those activities which bring recreation and mental enjoyment to the public. Further, our organization is an interpreter of nature, and who is to say that the troubles civilization is cursed with to-day do not arise, in large part, from a lack of comprehension of nature's laws?

There is, of course, another reason for pressing forward vigorously with the work of institutions such as ours. Only in this hemisphere can it now be done. There is a saying of the Ancient Greeks, "Keep the torch alight!"

There is not time here to present you with any detailed report as to our affairs. These will come out in our Annual Report, which will be sent to you. On the other hand, I do want to touch on some immediate realities and to inform you in what respects the year 1940 has proved so important in our development. Let me summarize the highlights. I shall commence with a report as to the "necessary element," shall we say the "sinews of progress."

Cash donations amounted to $121,000. Here is a significant fact. All these funds were received from men active in affairs who are keenly interested in forwarding our purposes—as distinguished from funds received through legacies. Further, all this money came from trustees and members of the society. In this is included the magnificent gift from an individual who wishes to remain anonymous. This gift has made possible the building of the new African Continental Exhibit in the Park. I might point out that the 1940 donations are the highest received in any one year since 1928 and the highest received for actual improvements, as contrasted with funds designated for general endowment within the last twenty-five years.

I am in danger of creating a misunderstanding. Endowed funds are obviously vital for our long-term planning, and a legacy for whatever purpose—well, need I say more! Yet the nature of the past year's support is most attractive. It is good for men to live to see the progress that their generosity makes possible!

Why should we receive funds and for what new purposes will they be used?

First, we have evolved and devised new conceptions of what a zoological park or aquarium should be. For the first time in any zoological park here or abroad, we are carrying out plans, on a broad scale, of exhibiting our live collections according to their distribution by continents. This is a basic change, and will provide the public with an infinitely clearer understanding of the history and relationships of animal life on this earth.

Further, we are determined, in so far as possible, to take our animal collections out "from behind the bars." In a few moments you will see some moving pictures of lions taken only last week in their new freedom in the Zoological Park. I haven't the least doubt that from now on you, our members and friends, together with the public at large, will agree that we must, to the greatest extent possible, liberate our unique collections from many of their present types of cramped enclosures. The animals are entitled to it, and the public will get a far better conception of the beauty and behavior of animal life if we carry through a general program of exhibiting our collections in areas expressive of freedom and of natural

[1] Read before the annual meeting of the society, at the Waldorf-Astoria Hotel, New York, January 14.

environment. From the point of view of public psychology this is of vital importance.

We are making another departure, which can best be described by telling you that on the great entrance walls to the new African Exhibit there will be written the story of the development of life on the continent of Africa through tens of millions of years. We believe this plan will prove to be an example of popular education in zoology in its most effective form. Here again, as far as we know, no such ideas have ever been carried out by any other zoological park. The treatment we have in mind will not find its parallel in any museum. I must take this occasion, however, to express our deep gratitude to our sister institution, the American Museum of Natural History, for the invaluable help it has given us in the preparation of the material involved.

Now, as to scientific objectives. Perhaps we can best illustrate our intention of pressing forward with our scientific work on all fronts by informing you that in 1940 the Board of Trustees voted a larger amount of money for the encouragement of our scientific work than in any previous year in the history of the society. There is one new angle concerning which I wish to tell you. We are working on plans to make the society a clinical center, not only as regards the greater City of New York, but for the country as a whole, for the study of animal diseases in their relationship to human disease problems. Raymond Dochez, whom we have had the honor to elect to our Board of Trustees to-night, is, with many others, helping us in formulating this program. And we hope to gain the financial support during the current year which will enable us to get this program under way. Its significance in connection with human health of the future may well be greater than any of us can now foresee.

I have been speaking of plans at the Park. Do not think that we are lacking for many new ideas in regard to the Aquarium. The solid walls of that century-old building prevent the application of most of them. Only through the medium of a new Aquarium building can justice be done to the miracle of marine life, presented through modern exhibition technique.

The World's Fair already seems like yesterday. Our Exhibit Building provided enjoyment and instruction to 399,000 visitors. This enterprise has proved of great value to the society in many different ways and should be a matter of lasting satisfaction to the generous group among our trustees who made it possible.

Our new general director, Mr. Jennings, with his able assistant director, Mr. Sweeny, is bringing to our problems not only the abilities which come from wide experience in the administration of a public institution, but also a high degree of intelligence and enthusiasm in connection with the development of our popular education and scientific objectives. It is not possible to do justice to the enthusiasm and creative work which is being done by our entire staff.

Mr. Jennings in his report has given you some idea of other activities which are going forward. The continuity of really liberal support by the city government will depend, obviously, upon how effectively we function as a public institution serving our millions of visitors each year. I remind you that we have an enormous annual visitor list, running to five million persons a year, far greater than that of any other institution of its kind in the greater city, or for that matter, in the country.

I wish also to express appreciation for the cooperation we are receiving from the city government. Commissioner Moses and his assistants in the Park Department are showing us the finest cooperation. The same, we are extremely glad to say, holds true for the attitude shown us by the mayor, the budget director and other city officials.

One word as to membership. I do not think you realize how you, yourselves, can help in drawing to us new members and friends. We greatly need that help. I wish also to tell you that at an early meeting of the board we intend to amend our by-laws to provide for a junior membership for children up to the age of 18, at a reasonable annual fee. We entertain great hopes in building up a following through the years to come, among the youth of the city and neighboring communities.[2]

OBITUARY

DAYTON CLARENCE MILLER

Things are where things are, and as fate has willed, so shall they be fulfilled.

—*Browning*

WITH sadness, the world of physics notes the passing of Dr. Dayton Clarence Miller, who died at his home in Cleveland, Ohio, on February twenty-second of this year.

Son of Charles Webster Dewey Miller and Vienna (Pomeroy) Miller, Dayton Clarence Miller was born in Strongsville, Ohio, on March 13, 1866. His father,

[2] In his closing remarks President Osborn stated that the Zoological Society of the future intended to place greater and greater emphasis, in connection with the unrivaled collections both at the Zoological Park and the Aquarium, upon the interpretation of the meaning of animal life—in other words, the extension by every means possible of the processes of popular education in zoology.

ginally a farmer, later became a merchant, a nker and electric traction executive.

Dayton Clarence Miller attended Baldwin-Wallace llege in Berea, Ohio, situated only a few miles from birthplace. There he was graduated in 1886 with degree of bachelor of arts and in 1889 with the gree of master of arts. During the last year of his udies at Baldwin-Wallace he was in charge of in-uction in natural science. Having become inter-ted in astronomy, he went to Princeton University, ere for two years he studied astronomy with Pro-ssor Charles A. Young and also took courses in the partment of physics. But it was astronomy to hich he devoted most of his attention. Small of ature, the students would refer to him and Professor oung, as they proceeded to the observatory, as "big d little twinkle." He received the degree of doctor science from Princeton in 1890, his thesis having en the computation of the orbit of a comet. In the tumn of the same year he became instructor of athematics and physics at Case School of Applied ience and successively assistant professor and head ofessor of physics. He remained on the faculty of at school for fifty years, retiring from active service June, 1940.

In 1893, Dr. Miller married Edith C. Easton, daugh-r of Francis Cory Easton and Susan (Robbins) aston, of Princeton, New Jersey. Mrs. Miller, who rvives him, was his constant companion, serving in any ways to aid him in his work.

It was not long after Dr. Miller began his work at ase School before his interest and enthusiasm for his bject, together with his rare teaching ability, enabled im to have the funds provided for the erection of a uch needed building, the Rockefeller Laboratory of hysics. This structure, with its many unique fea-ures, was designed by Dr. Miller, and the fine experi-ental equipment, especially of standards and acous-ics, was the result of his careful selection. The isitor's book in the laboratory, containing the auto-raphs of famous physicists, is a testimony of his opularity. One day, in the early nineties, Dr. Miller emarked to the writer (one of his earliest students) hat "Sound is a neglected branch of physics." This emark, perhaps, presaged the thorough and extensive xperimental work in sound to which he devoted the ajor part of his life.

Although Dr. Miller felt that he had received his reatest inspiration from President McCosh and Pro-essor Young of Princeton and Professor Edward W. Morley of Western Reserve University, it is perhaps rue that his interest in research was due primarily o a fortuitous acquaintance with the latter. The Millers and the Morleys happened to find themselves iving in the same building and eating three daily meals together. Small wonder, then, that Dr. Morley, working on the adjacent campus of Western Reserve University and recognizing Dr. Miller's experimental skill, soon asked him to collaborate in research, the principal one of which was an improved repetition of the Michelson-Morley Ether-Drift Experiment. Later, as is well known, Dr. Miller, alone, repeated the ex-periment many times, his efforts culminating with his painstaking observations on the top of Mt. Wilson in 1925–26. The number of individual interferometer readings made by himself was 200,000. Continually, he insisted that recognition should be given to the small positive result which he and both Michelson and Morley had observed. This result, he believed, was a sufficient refutation of the Einstein relativity theory.

But Dr. Miller's chief contributions were in the field of acoustics, his favorite subject. The phonodeik, which he invented, not only made visible the complex wave-forms of sound waves but magnified the ampli-tudes as much as 2,500 times. With this instrument and accessory apparatus, Dr. Miller conducted many researches concerning the tone quality of numerous musical instruments, of the voice and of other sources of sound. His determination of the velocity of sound waves in air, made with big guns during the first World War, is, perhaps, the most accurate yet made. He was frequently consulted with reference to the proper design or treatment of large auditoriums in order to improve their acoustic qualities. Among these may be mentioned the chapels of the universities of Chicago, Denison, Princeton and of Bryn Mawr College. The auditoriums of the National Academy of Sciences in Washington, D. C., of many churches, hospitals, theaters and schoolrooms and finally of Severance Hall, the home of the Cleveland Symphony Orchestra, also received his attention.

Dr. Miller was much interested in symphonic and operatic music. He composed about thirty pieces of music for the flute, piano and other instruments. His special interest in the flute, on which he was an excel-lent player, is well shown by the magnificent collection of over 1,400 flutes dating from earliest times to the present. This fine collection along with books, pamphlets, music, works of art, pictures, autographs and portraits, perhaps the finest in the world, he has given to the U. S. Government, where it will be fittingly exhibited in the Library of Congress in Washington, D. C.

In order to come into close contact with other work-ers, Dr. Miller traveled extensively to almost all the states of the union and fifteen times to Europe. His pleasing personality along with the gift of presenting his subjects simply to lay audiences contributed greatly to the popularization of science. He delivered over 500 popular lectures in the United States and

Canada. These lectures, experimentally illustrated, dealt with such subjects as x-rays, polarized light, radium, visible sound, ether-drift and the history of the flute. At the Lowell Institute, in 1914, he gave the course of eight lectures on "The Science of Musical Sounds." He also gave lectures in Paris, Berlin, Cambridge (England), the Royal Institution in London and the Franklin Institute.

An indefatigable worker, in addition to his contributions to scientific journals, Dr. Miller found time to write the following books:

1. "Laboratory Physics" (1903), a college manual which has passed through twelve editions.
2. "The Science of Musical Sounds" (1916).
3. "Boehm on the Flute and Flute-playing" (1908 and 1922).
4. "The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth" (1933).
5. "Anecdotal History of the Science of Sound" (1935).
6. "Catalogue of Books and Literary Material Relating to the Flute" (1935).
7. "Sound Waves: Their Shape and Speed" (1937).
8. "Sparks, Lightning, Cosmic Rays" (1939).

Of the many learned societies of which Dr. Miller was a member or fellow we note "The National Academy of Sciences," "The American Philosophical Society," "The American Academy of Arts and Sciences" and "The American Physical Society." Besides holding important offices in a number of the societies he was honored in 1917 by the award of the Longstreth Medal and in 1926 of the Elliott Cresson Gold Medal of the Franklin Institute for his work in acoustics. In 1925 he was awarded the American Association for the Advancement of Science prize for his paper on "Ether-Drift." In 1928 the Cleveland Chamber of Commerce bestowed on him its Distinguished Service Medal. Honorary degrees came to him from Case School, Western Reserve University, Baldwin-Wallace College, Miami University and Dartmouth College.

Constantly at work but never too busy to receive his callers and if possible to aid them, gentle and modest in manner, Dr. Miller leaves behind a host of students and friends who mourn his passing but rejoice that they had the opportunity to receive from him that intangible something called inspiration which they will never forget.

Courageous to the last, loth to let his friends know of the approaching end, of which he was becoming aware, he continued to go to the laboratory until the day before his death, rarely missing the occasion of daily lunching with his comrades. He had so lived that when his summons came, "sustained and soothed by an unfaltering trust," he approached his end "like one who wraps the drapery of his couch about him and lies down to pleasant dreams."

The Moving Finger writes; and having writ,
Moves on: nor all your Piety nor Wit
Shall lure it back to cancel half a Line,
Nor all your Tears wash out a Word of it.

—*Omar Khayyám*

H. W. MOUNTCASTLE

WESTERN RESERVE UNIVERSITY

SCIENTIFIC EVENTS

THE ONE HUNDREDTH ANNIVERSARY OF THE ESTABLISHMENT OF THE ALEXANDER DALLAS BACHE MAGNETIC OBSERVATORY

A MEETING in commemoration of the life and work of Alexander Dallas Bache was held in Philadelphia on February 14–15, as a fitting observance of the one hundredth anniversary of the establishment by him of the first magnetic observatory in America. The program of the meeting was in part historical and in part a symposium on geomagnetism. The sessions were held at the building of the American Philosophical Society and in the chapel of Girard College.

Alexander Dallas Bache was a man of abundant energy, which overflowed in many directions. Born in Philadelphia in 1806, a great-grandson of Benjamin Franklin, he was graduated from West Point in 1825 at the head of his class, although its youngest member. He served with the Army Engineers at Newport, R. I., and in 1828, at the age of twenty-two years, was elected professor of natural philosophy and chemistry in the University of Pennsylvania. In 1836 he became the first president of Girard College, where he established his magnetic observatory in 1840. He served also as president of the Central High School and superintendent of schools of Philadelphia. In 1834 he was appointed superintendent of the U. S. Coast Survey, which position he held until his death in 1867. He was president of the American Association for the Advancement of Science in 1850 and of the American Philosophical Society in 1855. From 1863 to 1867 he was president of the newly organized National Academy of Sciences, in whose establishment he played an influential part.

In the historical part of the program, on the morning of February 14, Bache's various scientific connections were described by Dr. E. G. Conklin, of the American Philosophical Society, Professor E. P. Cheyney, of the University of Pennsylvania, Secretary Henry Butler Allen, of the Franklin Institute, Rear Admiral L. O. Colbert, of the U. S. Coast and Geodetic Survey, and Dr. Frank B. Jewett, of the National

Academy of Sciences. All the speakers brought out the fact that Bache could not become a member of a society without taking an active part in its proceedings, and that he left the imprint of his administrative ability on all the organizations with which he was connected.

The symposium on geomagnetism was planned to give a general view of the progress that has been made in our knowledge of the subject during the hundred years since Bache founded his observatory. This "century of progress" witnessed the important discoveries of earth currents, of electric currents in the upper atmosphere, of the electronic bombardment of the earth by the sun and of the cosmic rays. The influence of these factors on the earth's magnetism and on radio transmission was described in twelve papers by John A. Fleming, O. H. Gish, A. G. McNish, H. Freeborn Johnston and L. V. Berkner, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington; by N. H. Heck and H. E. McComb, of the U. S. Coast and Geodetic Survey; by E. A. Eckhardt, of the Gulf Research and Development Company; by Carl W. Gartlein, of the Department of Physics of Cornell University; by J. H. Dellinger, of the National Bureau of Standards; by H. E. Hallborg, of R. C. A. Communications, Inc., and by Thomas H. Johnson, of the Bartol Research Foundation.

The program for the afternoon of February 15, at Girard College, was of a more popular character, the audience including about a thousand students of the college. President Merle M. Odgers, of the college, described Bache's work as an educator, and Paul R. Heyl, of the National Bureau of Standards, spoke on "Magnetism and Its Uses," giving the historical development of the subject from the earliest times.

All the papers presented at the meeting will be published by the American Philosophical Society.

Paul R. Heyl

National Bureau of Standards

PAN-AMERICAN UNION AGAINST CANCER

A Pan-American Union against Cancer was incorporated a few days ago by a prominent group of physicians, business men and lawyers who are interested in the problems of cancer research, therapy and education as coordinated aspects of an effort which it is hoped will some day lead to the control of a disease, which is becoming more and more effective as improved methods of treatment are being developed. The organization is an offspring of the International Union against Cancer, which was formed in Paris in 1934. The president of that Union was Senator Justin Godart, French Minister of Public Health during the World War. Since the occupation of France, the Union has obviously become inactive. In order to carry on the work in which this international organization assisted, it was suggested by Senator Godart a few months ago that a Pan-American organization be started to include the same groups as were a part of the older organization. The only officials in the United States were Boris Pregel, who was one time chairman of the Finance Committee of the International Union; L. W. Tomarkin, who was executive secretary, and the writer of this note, who was a vice-president. The new association just formed will follow in the footsteps of the International Union and hold a Cancer Congress in Buenos Aires in 1942. Representatives of Canada, the Philippines and most of the South American countries have renewed their allegiance to the new representative of the old International Union. The new organization will, as effectively as possible, aid in the various problems which come up in public education, concerning cancer, in the conduct of scientific meetings and, when funds become available, the publication of proceedings. Its activities will in no way conflict with those educational and research organizations already in existence in the various countries which have joined the league.

Francis Carter Wood

THE NINETEENTH ANNUAL PLANT SCIENCE SEMINAR

The nineteenth annual Plant Science Seminar will be held at the Cranbrook Institute of Science during the week of August 11–15. Cranbrook is an educational center occupying 300 acres of wooded land in Bloomfield Hills, Mich., about 20 miles north of Detroit. Its Institute of Science was established as an aid to the diffusion of scientific knowledge and as an instrument of research and discovery. The Institute of Science occupies a building opened in 1938, where are provided exhibition space and well-equipped laboratories, library and auditorium. Housed in the building is the largest natural history museum in greater Detroit. Local natural history is emphasized and the museum is rapidly becoming the mecca for students and scientists of southeastern Michigan.

The region about Bloomfield abounds in variable flora and many distinct plant communities are to be found. A number of botanical excursions through this typically glaciated country are planned. Visits will be made to the Medicinal Plants Farm at Parkedale and to the Oakview Seed Breeding Institute of the Ferry-Morse Company and a visit to the Todd Mint Farms near Kalamazoo is being tentatively arranged.

Some of the leading pharmaceutical botanists and pharmacognosists will appear as speakers on the program and their subjects will be announced in the near future.

J. Russell Anderson, 15851 Evanston Avenue, Detroit, Michigan, is the local secretary.

THE UNION COLLEGE SCIENCE SYMPOSIUM

According to the preliminary program, the Science Symposium entitled "Science Views Man," which is being held at Union College on March 21 and 22, opens at 2 o'clock on Friday with an address by Professor A. J. Carlson, of the University of Chicago, entitled "Man's Body and Man's Behavior." This address is to be followed by discussion led by Professor Elbert C. Cole, Williams College; Professor Clarence F. Graham, Albany Medical College; Professor Harold E. Himwich, Albany Medical College, and Professor James Watt Mavor, Union College.

In the evening Professor Bronislaw Malinowski, professor of anthropology at the University of London and now visiting professor at Yale University, will make an address on "Man's Culture and Man's Behavior." The discussion will be led by Dr. Charles C. Adams, director of the New York State Museum; Professor Everett V. Stonequist, Skidmore College; Professor John L. March, Union College, and Professor Harold A. Larrabee, Union College.

Members of the symposium have been invited to attend on Friday afternoon at 4 P.M. a Research Laboratory colloquium at the General Electric Company, conducted by Dr. Warren S. McCulloch, of the Neurophysical Laboratory of the School of Medicine of Yale University.

At 11 A.M. on Saturday morning there will be a panel discussion on "Science in the News" led by Waldemar Kaempffert, *chairman*, science editor, *The New York Times;* Watson Davis, editor, *Science Service;* John J. O'Neill, science editor, *The New York Herald Tribune;* David Dietz, science editor, *The Scripps-Howard Newspapers;* Gobind Behari Lal, science editor, *The International News Service,* and Gustav W. Stamm, managing editor of *Science Digest.*

The panel will be followed by a luncheon at which Dr. Willis R. Whitney, founder of the Research Laboratory and vice-president in charge of research of the General Electric Company, will speak.

In the afternoon Dr. Kirtley F. Mather, professor of geology at Harvard University, will speak on "Man's Physical Environment and Man's Behavior." His address will be followed by a discussion led by Professor Elwyn L. Perry, Williams College; Professor Oskar D. von Engeln, Cornell University; Chris A. Hartnagel, state geologist of New York, and Professor Edward S. C. Smith, Union College.

There will be a reception and tea at five o'clock, tendered the members by President and Mrs. Dixon Ryan Fox and the committee on arrangements, of which Dr. Edward Ellery is chairman. Dr. Harlow Shapley, Paine professor of astronomy at Harvard University and director of the Harvard Astronomical Observatory, will make an address in the evening entitled "Man's Place in the Universe."

THE HUNDREDTH ANNIVERSARY OF THE NEW YORK UNIVERSITY COLLEGE OF MEDICINE

The centennial celebration of the New York University College of Medicine was planned for March 21 and 22. It will open with a dinner at 7:30 P.M. at the Hotel Roosevelt. Approximately 700 alumni, faculty and friends of the university, including professional, business, religious, educational and civic leaders, will attend the dinner to hear addresses by W. Somerset Maugham, novelist and physician; Dr. James Rowland Angell, counselor for public service programs of the National Broadcasting Company; Chancellor Harry Woodburn Chase, and Dr. Currier McEwen, '26, dean of the College of Medicine. Dr. Luther B. MacKenzie, '04, president of the College of Medicine Alumni Association, will be toastmaster.

An all-day alumni program of scientific meetings will be held on March 22, supplemented by demonstrations and exhibits. Speakers at a luncheon meeting are Dean Emeritus Samuel A. Brown, '94; Dr. Nathan B. Van Etten, '90, president of the American Medical Association, and Dean McEwen.

An illustrated history of the College of Medicine has been prepared for the centennial celebration by Dr. Claude Edwin Heaton, '21, assistant clinical professor of obstetrics and gynecology.

Mileposts in the history of the institution to which Dr. Heaton called attention include

> a winning fight nearly ninety years ago to legalize dissection for the study of anatomy in New York State; pioneer work in military surgery in the Civil War which resulted in the organization of the United States Sanitary Commission; a report which led to the establishment of the modern New York City health department; leadership in organizing the first training school for nurses in America planned along the ideas of Florence Nightingale, and more recently, the establishment of the first department of forensic medicine in this country.

When the College of Medicine was opened on the site now occupied by the Broadway Central Hotel, the first faculty consisted of Dr. Mott, Dr. Draper, Dr. Martyn Paine, professor of medicine; Dr. Granville Sharp Pattison, a leading teacher of anatomy; Dr. Gunning S. Bedford, credited with establishing gynecological teaching on a solid basis in this country; and Dr. John Revere, youngest son of Paul Revere.

Some twenty years after the establishment of the college, then known as the "medical department" of the university, the Bellevue Hospital Medical College was opened on the grounds of Bellevue Hospital. The two institutions were merged in 1898 as "the University and Bellevue Hospital Medical College," a name

that continued until the spring of 1935 when it became the New York University College of Medicine. The college established its own clinic fifty-eight years ago and since that time has treated more than 1,000,000 patients.

This year the college has an enrolment of 499 students and a faculty of 514 men and women. The instructional staff includes 51 full-time teachers and 463 practicing physicians devoting part of their time to teaching at the college. The centennial senior class, which will be graduated this June, consists of 123 young men and women, 92 of whom will become internes in the hospitals of the city.

During the past century 10,900 individuals have been graduated. Dean McEwen pointed out that three out of four students are natives of New York and that one out of every seven doctors in the city is a graduate of the college of medicine.

Among the 10,900 physicians graduated by the college during the past century were Walter Reed, William Crawford Gorgas and Hermann M. Biggs. Such leaders in American medicine as Valentine Mott, John W. Draper, Lewis A. Sayre, Austin Flint, William H. Welch, William Hallock Park and Charles Norris have at different times been members of the faculty.

PHYSICISTS AND NATIONAL DEFENSE

In his report to the annual meeting of the Governing Board of the American Institute of Physics, held on March 15, Dr. Henry A. Barton, director of the institute, estimated that 1,400 physicists, or one out of every four in the United States, are working on problems of national defense. This figure is based on surveys which are not yet completed and is probably a conservative estimate. According to the records of the institute there are from 4,000 to 6,000 physicists in the United States, depending on how a physicist is defined. 4,100 are members of at least one national professional society in physics.

A recent survey of more than 130 universities indicates that, of their total staff of 1,100 professors and instructors of physics, over 100 have recently been called away for official defense research projects. At least another 200 have been named consultants or assigned to full or part-time defense tasks at their home institutions. In addition, some 50 graduate students of physics have dropped their studies to accept defense assignments away from their institutions and another 35 at home.

Aside from these there are approximately 300 physicists in the technical services of the army, navy, air corps and other government departments, mostly full time, and of these at least 250 are at work on problems intimately concerned with national defense.

In industry it is estimated that 2,500 trained physicists are employed, many of them in the research laboratories of large corporations. On the basis of reports received, at least 800 of these have been assigned to new work programs in line with the needs of national defense. Indeed, if all work designed to improve or speed the production of defense materials and products be counted, the number is greater than 800.

Dr. Barton estimates that physicists are laying aside fundamental research and industrial development work and are turning to defense research at the rate of more than a hundred a month. The Civil Service Commission has recently modified regulations to encourage applications from physicists, not enough having been obtained to fill openings in the government service. Industries are applying to the institute for help in expanding their technical staffs, and the institute is unable to find men for them. Defense agencies are already handicapped and are finding it difficult to obtain seriously needed physicist personnel.

Not only is the "supply" of physicists being strained, but the "output" of new physicists is being curtailed. The men who have been called from universities for defense research are often those best fitted to train new research physicists. However, their remaining colleagues, actuated solely by patriotic motives, are generously assuming increased teaching loads, thus enabling the universities to keep up the standards of training offered to students.

Unfortunately, the careers of many students are about to be disrupted by the draft. Most of them are unmarried and of draft age. Unless something can be done to keep these much needed students in the graduate schools, the number of men receiving advanced training in physics will drop to less than half of the recent average of one hundred and thirty per year. What the country needs is to multiply this figure rather than to cut it down. Since a thorough training in physics requires three or four years of graduate study, it is nearly impossible to increase the annual increment of good new physicists. Every effort should be made at least to keep it up.

SCIENTIFIC NOTES AND NEWS

The meeting on March 20 of the Washington Academy of Sciences was devoted to the presentation of its awards for scientific achievement for 1940 as follows: For the *engineering sciences,* to Harry Diamond, National Bureau of Standards, "for his distinguished service in developing radio methods for aircraft navigation and for upper-air meteorological soundings." For the *physical sciences,* to Dr. F. G. Brickwedde,

National Bureau of Standards, "for his distinguished service in low-temperature researches on the different modifications of hydrogen and on the thermometry." The recipients were introduced by Dr. Lyman J. Briggs, director, and Dr. E. C. Crittenden, assistant director in research and testing, of the National Bureau of Standards.

AUSTIN H. CLARK, curator of the Division of Echinoderms of the U. S. National Museum, has been elected president of the Washington Academy of Sciences and vice-president representing the Entomological Society of Washington.

DR. M. L. FERNALD, Fisher professor of natural history and director of the Gray Herbarium of Harvard University, has been elected an honorary member of the Portland, Maine, Society of Natural History. He has also been elected an honorary member of the Pennsylvania Horticultural Society.

DR. F. W. KINARD, associate in physiology at the Medical College of the State of South Carolina, has been elected president, and Dr. J. E. Copenhaver, professor of chemistry at the University of South Carolina, has been elected vice-president, of the South Carolina Academy of Science. Dr. John R. Sampey, of Furman University, the retiring president, has been called to the army.

AT the recent annual meeting of the Columbia University Chapter of Sigma Xi officers were elected as follows: *President,* Dr. Selig Hecht, professor of biophysics, to succeed Dr. Horatio B. Williams, Dalton professor of physiology; *Vice-president,* Dr. Victor K. LaMer, of the department of chemistry; *Secretary and Treasurer,* Dr. George E. Kimball, assistant professor of chemistry. In addition to eighty-one graduate students, five members of the faculty were elected to membership. These are: Dr. A. Raymond Dochez, John E. Borne professor of medical and surgical research in the College of Physicians and Surgeons; Dr. Benjamin Tenenbaum, clinical assistant in the School of Dental and Oral Surgery; Dr. Dickinson W. Richards, Jr., associate professor of clinical medicine; Dr. Joseph Zubin, instructor in psychiatry, and Thomas Bradford Drew, associate professor of chemical engineering.

AT the annual meeting of the Parliamentary and Scientific Committee at the House of Commons on January 28, the Earl of Dudley was elected president for 1941 and Professor A. V. Hill was elected a vice-president. In an address to the committee Dr. Hill, according to the *British Medical Journal,* said that safeguards must be maintained to ensure the independence and integrity of science in the increased volume of state-aided research. He would like to see introduced into each department or organization some Scientific Advisory Council similar to that of the Ministry of Supply.

THE Buchan Prize for 1941 of the Royal Meteorological Society, London, has been awarded to H. L. Wright for papers contributed to the *Quarterly Journal* of the society during 1935–39.

AT the end of the current academic year, Dr. Roswell P. Angier, chairman of the department of psychology and associate dean of the Graduate School of Yale University, will retire after having been a member of the staff for thirty-five years, beginning with his appointment as instructor in psychology in 1906.

DR. WILLIAM E. LADD, clinical professor of surgery at the Harvard Medical School and chief of surgical services at the Children's Hospital, Boston, has been appointed the first William E. Ladd professor of surgery, a chair which has been permanently endowed by his friends and associates. This is the first Harvard professorship devoted exclusively to child surgery.

DR. HENRY S. SHARP, assistant professor of geology at Columbia University, has been appointed chairman of the department of geology of Barnard College.

PROFESSOR ELERY R. BECKER, of the department of zoology of Iowa State College, has succeeded Professor Joseph C. Gilman, of the department of botany, as secretary of the Iowa Academy of Science.

DR. A. B. WALKOM, secretary of the Linnean Society of New South Wales, has been appointed director of the Australian Museum.

DR. EDWARD H. KRAUS, dean of the College of Literature, Science and the Arts of the University of Michigan, is chairman of a committee to make arrangements for the centennial celebration of the college on October 10. A full day's program is planned to which representatives of leading educational institutions, members of the faculty and alumni are invited.

THE Committee on Scientific Research of the American Medical Association has made grants-in-aid as follows: Everett L. Evans, Medical College of Virginia, surgical shock; E. E. Cahn-Bronner, University of Illinois College of Medicine, bacterial metabolism; H. O. Burdick, Alfred University, Alfred, N. Y., effect of desoxycorticosterone on pregnancy; M. R. Todd, University of Oregon Medical School, physiologic effects of canine distemper vaccine; Roland K. Meyer, University of Wisconsin, antihormones.

AN Advisory Board on Blood and Blood Substitutes has been established by the Committee of Revision and the Board of Trustees of the Pharmacopoeia of the

United States to cooperate with and report through the Sub-Committee on Biological Assays. This board is made up of the following members: Dr. Perrin H. Long, of the Johns Hopkins University Medical School, member of the Committee of Revision, *chairman;* Dr. Edwin J. Cohn, Harvard Medical School; Dr. Sidney O. Levinson, Michael Reese Hospital, Chicago; Dr. C. P. Rhoads, Memorial Hospital, New York City, and Dr. Max M. Strumia, Bryn Mawr Hospital.

DR. TREAT B. JOHNSON, Sterling professor of chemistry at Yale University, has been granted leave of absence for the coming academic year. This is the first leave taken by Professor Johnson during a period of forty-one years of service in the department of chemistry.

DR. J. CHESTER BRADLEY, professor of entomology at Cornell University, who has leave of absence, is visiting institutions in the Eastern, Southern and Central States, and is collaborating with other specialists in preparing a field manual of insects of the Northeastern United States.

BRADFORD WASHBURN, director of the New England Museum of Natural History, has left for the West Coast to study the administration, both financial and educational, of leading natural history museums in that area.

DR. ALEXIS CARREL arrived on March 15 in unoccupied France, where he plans to make a study of the effect of food deficiencies on human health. He plans to remain in France for about six weeks. He will then go to Spain to continue his survey there.

THE Adam M. Miller Memorial Lecture of the Long Island College of Medicine will be given by Dr. Esmond Ray Long, director of the Henry Phipps Institute of the University of Pennsylvania, on March 28 at 4 o'clock. His subject will be "Environment and Constitution in the Development of Tuberculosis."

DR. ERNST ANTEVS, research associate of the Carnegie Institution of Washington, will deliver the address at the Sigma Xi banquet on April 28, in connection with the twenty-first annual meeting of the Southwestern Division of the American Association for the Advancement of Science. The meetings will be held at the Texas Technological College at Lubbock. The subject of the address will be "Climatic Variations in the Southwest during the Past 75,000 Years."

THE Hermann Michael Biggs memorial lectures, to be given under the auspices of the Committee on Public Health Relations of the New York Academy of Medicine, will be delivered by Dr. Clarence A. Mills, professor of experimental medicine at the University of Cincinnati, at the New York Academy of Medicine, on Thursday evening, April 3, at 8:30 P.M. The subject of the lecture will be "The Relationship of Climate and Geography to Health."

PRESIDENT RAY LYMAN WILBUR, of Stanford University, addressed the Congress on Dental Education and Licensure, held in Chicago on February 15. His topic was "Professional Education and Licensure."

THE seventy-first annual meeting of the Wisconsin Academy of Sciences, Arts and Letters will be held at the Milwaukee Public Museum on April 4 and 5. Dr. Loyal Durand, Jr., assistant professor of geography at the University of Wisconsin, is secretary-treasurer of the academy.

THE two hundred and forty-first regular meeting of the American Physical Society will be held in Washington on Thursday, Friday and Saturday, May 1, 2 and 3. The sessions of Thursday and Friday will be held at the National Bureau of Standards, those of Saturday at the National Academy of Sciences.

THE three hundred and seventy-ninth meeting of the American Mathematical Society will be held at the George Washington University, Washington, D. C., on May 2 and 3. This meeting will follow that of the National Academy of Sciences on April 28, 29 and 30, and will be partially concurrent with those of the American Physical Society, on May 1, 2 and 3, and the American Geophysical Union, also on May 1, 2 and 3. Sessions of the society will begin on Friday morning and continue through Saturday afternoon. By invitation of the program committee, addresses are to be given by Professor F. J. Murray, on "The Analysis of Linear Transformations," and by Professor I. M. Sheffer, on "Some Applications of Certain Polynomial Classes." There will be also a symposium on the Rayleigh-Ritz method and its applications, containing three brief addresses, one each by a mathematician, a physicist and an engineer. These will be followed by both formal and informal discussions. There will be a subscription dinner at the Cosmos Club on Friday evening. The Willard Hotel has been chosen as hotel headquarters.

THE New York State Section of the American Physical Society will meet at Oneonta, N. Y., on April 5. A conference has been arranged on "Secondary School Problems Relating to Physics and the Physical Sciences," in which a number of high-school teachers will take part.

A CONFERENCE on "immunochemistry" will be held at the American Museum of Natural History on March 28 and 29 by the Section of Physics and Chemistry of the New York Academy of Sciences. There will be an informal subscription dinner at the museum restaurant on March 28.

FURTHER appointments of Research Associates will be made at Battelle Memorial Institute, Columbus, Ohio. Young men who are college graduates and who have shown exceptional aptitude for research, either in graduate work or in a brief industrial experience, are eligible. Preference will be given to those who have majored in physics, physical chemistry, organic chemistry, chemical engineering, metallurgy, fuels or ceramics, and especially to those who have completed their Ph.D. training and who are planning a career in industrial research. An appointment as Research Associate is for one year, including vacation, and may be extended for a second year. The salary is $1,800. Research Associates work full time on approved research projects under the supervision of the Battelle technical staff.

THE London *Times* states that the University of Edinburgh has established a Polish School of Medicine. This will be staffed by professors and teachers now serving with the Polish Army in Great Britain and by professors of the University Faculty of Medicine in such subjects as may not be represented among the Polish professors. A statement issued by the university reads in part: "The Polish Forces in this country include a considerable number of medical officers of whom many are men of high academic standing who have held important teaching and research appointments in Poland. In addition, there are other medical graduates of Polish universities who have lost for the present almost all opportunities of maintaining the standards of their professional skill. There are also numbers of Polish medical undergraduates in this country, and the value of their studies will be seriously affected unless something is done to mitigate the unfortunate situation in which these men now find themselves."

THE Dublin Institute for Advanced Studies was founded last October. According to *Nature,* it consists of two constituent schools, the School of Celtic Studies and the School of Theoretical Physics. The institute will provide facilities for advanced studies and research in special branches of knowledge and for the publication of the results of such studies, irrespective of whether they have originated from the institute or not. Members of the governing board of the School of Theoretical Physics include Professors A. W. Conway, *chairman;* F. E. W. Hackett, A. J. M'Connell; W. H. McCrea, Belfast; A. O'Rahilly, Cork, and E. T. Whittaker, Edinburgh. The scope of the school is described as the investigation of the mathematical principles of natural philosophy and their application to the sciences in which they obtain. Both the training of advanced students in methods of original research and the provision of research facilities for professors and lecturers on leave of absence from their academic duties will be included. The first senior professor appointed to the school is Professor E. Schrödinger, formerly of the University of Graz.

T. H. VAN DEN HONERT, acting director of the Buitenzorg Botanic Gardens at Java, writes to SCIENCE: "The *Annales du Jardin botanique de Buitenzorg* up till now have been published at Leyden, Holland. As the European territory of the Kingdom of the Netherlands is now occupied by the enemy, a new series under the name of *Annals of the Botanic Gardens, Buitenzorg,* has been started in Java. This periodical will cover the whole field of pure botany, including plant physiology, morphology, anatomy, cytology, ecology and microbiology. It will contain contributions by the regular staff and visitors to the scientific institutes of the Botanic Gardens as well as from other sources. The editor's mailing list is, however, not available in Java. As it is intended to continue exchange as usual, it seems advisable to renew or confirm each exchange. The same holds for the subscriptions to the new series. The price per volume is fixed at fl. 10. Therefore, subscribers and others interested in this periodical are requested to communicate with the Director of the Botanic Gardens, Buitenzorg, Java, D.E.I."

DISCUSSION

THE MUSEUMS OF NEW YORK

IN a recent unasked-for report to the mayor of New York City the commissioner of parks takes it upon himself to submit a blanket adverse criticism of the museums, zoological park, aquarium, botanical gardens and public library of New York. It is proffered by one with no known experience in either science or education. From correspondence and conversation with officials of these institutions it seems fairly evident that the criticism is based chiefly on the reports of others, for apparently the commissioner of parks, with possibly one or two exceptions, has not inspected these institutions in person since he came into office.

It is not only the museums as they stand that

are criticized, but the motives and the personal character and conduct of the founders and their successors, and the aims and ideals and organization of the museums. He finds almost everybody and everything inefficient, wasteful and wrong. The boards of trustees constitute a "House of Lords" or an "exclusive social club." Only those who are rich (especially the newly rich) and have "Society" status can qualify as board members. Ex-officio members of these boards —the mayor, the comptroller and the park commissioner—are not welcome to the meetings, and the boards resort to a cunning subterfuge to keep them outside the inner councils. "The greatest mistake a public official can make," says the report, "is to concede that there is something occult, esoteric or sacred about these institutions. This is, of course [*sic*], the atmosphere with which, in the past, the trustees have surrounded them."

In addition to the three ex-officio trustees, there should be "a third class consisting of a minority appointed for overlapping terms by the Mayor," apparently to keep careful watch to see that proper standards are set and realized, and in particular to see that the museums are organized with reference to the mental and cultural requirements of "the average roughneck outside," rather than those of the "comparatively few really cultivated people" who visit them.

The priceless treasures of objects of art and science that constitute the exhibits are referred to as "the loot" contributed by "new millionaires" determined to make a public exhibition of their wealth.

The report also shows considerable ignorance, for a trustee, as to what institutions in the city have any official relations to the city, for such institutions as the New York Historical Society, the Museum of the American Indian, Heye Foundation, the Brooklyn "Institute at the Academy of Music," are treated like the Metropolitan and the American Museums, although they are located on their own property and are supported wholly from private funds.

The trustees of the various institutions are treating the report as it deserves to be treated—with complete indifference and silence. But no one acquainted with municipal politics in American cities will fail to see in this report evidence of the danger which both trustees and city officials sought to guard against when the written agreements were entered into between the two bodies, namely, to take every reasonable precaution against the institutions falling into the hands of politicians, as ignorant as the writer of the report shows himself to be of the aims and purposes of a modern museum. Since the time when P. T. Barnum established in New York City his "Museum" of freaks and marvels the idea has persisted in certain quarters that the only function of a museum is to place exhibits on view, suited chiefly to "the average roughneck outside."

A brief historical survey may not be untimely here. Some sixty or seventy years ago two groups of men, interested in the promotion of popular education and culture, organized themselves into two "boards of trustees" to initiate and develop, one, a museum of natural history, the other, a museum of art. One familiar with the cultural history of that period in America knows how great was the need for such institutions. In the length and breadth of our country there was nothing of the kind. Public schools there were, and colleges for the higher education of those who felt the need of it and could afford it, but no institution for the free dissemination among the people of the enjoyment and appreciation of the best in art, and the diffusion among adults and children of a knowledge of man and nature. No branch of our government—federal, state or municipal, had ever made the slightest move toward the establishment of institutions with such aims.

What are the requirements to make such institutions succeed? First, an interest in the public welfare; second, an interest in science or art as the case might be, and an understanding of the importance, in a democracy, of spreading this interest and knowledge among the people; and third, the possession of wealth and a disposition to use it for human betterment; for money is the indispensable prerequisite for the promotion of anything for the benefit of mankind. Even religion must be financed by some one.

When these two organizations were started each group sought to find others who would join with them in the enterprise, and two boards of trustees were built up. The sole aim was public service—the sole requirement for membership on the board was the ability to contribute strength of *some* sort—interest in the subject-matter, interest in popular education, interest to make New York City a better place to live in.

The importance of the work and its universal character made it essential to have the various groups of the community represented on the boards, and special care was taken to have Catholics, Protestants, Jews and other groups represented—as they now are. Some were chosen for their enthusiasm for science or art, some for their influence with possible sources of cooperation and support, some for their positions of trust in the community, some for their experience in education, some for their knowledge of finance, and always it was important, and always will be, to have some men of wealth and a tradition or disposition to use their wealth for public service. It was a characteristic movement of American democracy. How disregardful of all the facts to speak of any of these boards as "a House of Lords" or "an exclusive social

club" or to try to impugn or belittle the motives of the men. If *any one* has anything to contribute—of knowledge or ideals or funds—that will make our museums more interesting and more effective educationally, he would certainly be welcomed on any board.

And how the money has poured in! Millions of dollars freely contributed solely for the public welfare. The City of New York has never, if we are correctly informed, appropriated a penny for the purchase of any of the marvelous collections of objects of art and natural science on display every day of the year, in every city museum, free at all times to all visitors. The city provides the sites, buildings and maintenance—heat, light, upkeep of buildings and grounds as it properly should. In some cases it meets a portion of the cost of curatorial services, in some cases none. The exhibits are provided from private funds.

We sometimes wonder how many of the millions who visit these great public institutions every year ever stop to consider that they are indebted to some one for making such opportunities possible or who that "some one" is. It is high time that these facts were generally known and appreciated.

No sane person would, for a moment, contend that our museums, our botanical gardens, our zoos are perfect. The church is not perfect, banking is not perfect, business is not perfect, our schools and colleges are not perfect; they are all human institutions, and nothing human is perfect. But the fact remains that the American Museum of Natural History and the Metropolitan Museum of Art, not to mention the other institutions, are recognized by competent authorities, both here and abroad, as among the greatest and most effective institutions of their kind in the world. There is every evidence that the local public (the taxpayers) and out-of-town visitors are unanimous in this verdict.

It is the dual function of a museum to advance knowledge as well as to disseminate it. It would be wholly out of the range of possibilities to produce such an exhibit as, for example, the dinosaur hall in the Natural History Museum without a staff of creative scientists. The material could not be collected and installed merely by "popularizers." It must be authoritative or it would be worse than useless. Creation in science means research. It is distinctly not the purpose of museums to be merely purveyors of second-hand information. And every year their emphasis is more and more on popularization and public service while maintaining the highest standards of science and art.

Moreover, it should be kept in mind that our museums are not *exclusively* for "the average roughneck outside," as Mr. Moses seems to imply. While they do not discharge their full function "if a comparatively few really cultivated people understand and visit them," nevertheless it is an important part of their obligation to serve the "comparatively few really cultivated people"; they certainly pay their share of the taxes. Educational standards are not raised by adjusting them to the mediocre, in museums any more than in colleges. It is the perpetual challenge of education to elevate the general intelligence, if possible.

Like the mayor and the comptroller, the park commissioner is *ex officio* a member of the board of every one of these semi-public institutions that is located on city-owned property. His status as such is no different from that of any other member of the board. He has not only the honor but the obligations and duties of a board member. If he sees opportunities to improve the museums the most direct and effective way to bring that about would be to attend a board meeting in person, outline the changes or innovations he thinks desirable, and have them freely discussed. He may rest assured that if such proposals are commendable and feasible they would be gladly adopted, not only by New York City museums, but by those in other cities as well.

MUSAEUS

THE ECR IS PROGRESSING

SINCE the notice of January 17 appeared in SCIENCE concerning the proposed Encyclopedia of Chemical Reactions more than fifty persons have volunteered to aid in the abstracting of the remaining chemical journals for the work. This response has been far beyond expectations.

In making a progress report I wish to state that at this time (February 22) there are 69 listed collaborators and abstractors for the ECR. In addition to these there are 18 volunteers who have not yet been given abstracting assignments, raising the total ECR personnel to 87. There are 147 chemical journals on our revised list to be covered. This list now contains all the journals that are likely to yield any inorganic chemical reactions in the modern sense. Out of this number forty-one journals have already been abstracted, and the reaction cards filed. Forty-three others have so far been assigned to abstractors, and are now being worked over.

If the 18 unassigned volunteers will each take one of the remaining journals we should still have 45 left, for which other abstractors will be needed. The journals yielding numerous reactions suitable for the ECR are comparatively few, but some of them are so long that it will require half a dozen or more abstractors for each set, in order not to make the work too tedious. On the other hand, some journals in related fields yield

no reactions, or very few, but nevertheless they should be looked over.

In the revised list of journals the abstractor's number, to whom the journal has been assigned, follows the name, and two check marks indicate that the journal has been finished. This list, together with abstracting rules, will be sent to any one else desiring to have a part in this worth-while undertaking.

C. A. Jacobson,
Editor in Chief
West Virginia University

PIGEON MALARIA IN CALIFORNIA

For many years, the presence of a sporozoan malarial parasite in pigeon blood has been known to produce a disease of economic importance. The causative organism of pigeon malaria is *Haemoproteus columbae* Celli and San Felice. The parasite can be transmitted from bird to bird only by means of a blood-sucking vector, a hippoboscid fly, *Pseudolynchia canariensis* (Macq.). Bishopp[1] states that this fly was introduced into the United States about 1896. It is distributed throughout the southern states and in California.

Although pigeon malaria has been reported from many parts of the United States, to our knowledge, no previous record exists which establishes its presence in California. Our interest was aroused when a report came to us from a Southern California squab farm that birds infested with *P. canariensis* showed signs of unthriftiness. The symptoms were quite variable in intensity, ranging from mild to severely morbid states. Examination of blood samples from these birds showed the erythrocytes to be parasitized by *H. columbae*.

The extent of the disease in California has not been determined. A survey is in progress with this object in view. The presence of the parasite should stimulate the application of vigorous control measures against the fly vector.

Carl G. Kadner
Department of Biological Sciences,
Loyola University of Los Angeles

SPECIFICITY OF RENIN

Under date of Friday, December 13, there appeared in Science, page 554, a note from the University of Buenos Aires relative to the absence of pressor response in man when swine renin is injected intravenously. In this connection we have the following to report.

Since February, 1940, we have experimented with hog renin in humans, the material employed having been prepared especially for us by Professor W. W. Swingle, of Princeton University, who reported that 0.1 mg per kilo of body weight of this material, given intravenously to anesthetized dogs over a period of two to five seconds, raised the mean arterial pressure 40 mm of mercury. We have thus far failed to obtain any significant elevation in blood pressure response in human beings with this material even when injecting intravenously quantities of renin, which appear relatively large. After cautiously experimenting with the material on ourselves, a group of 20 patients on Dr. Schnabel's service were tested for sensitivity by the intradermal injection. In two instances mild positive skin tests were obtained. On March 6, 1.76 mg of renin were injected intravenously into a patient, with no significant effect on blood pressure. The following day 2.9 mg were injected, with negative results. Since then we have injected this material in normal individuals and in patients suffering with hypertension in gradually increasing doses. Our last experiment was with a 38-year-old male, who was given rapidly 7 mg intravenously, without effect on blood pressure. Five minutes thereafter 14 additional mg were given intravenously, still without effect on the blood pressure.

It might be of interest also to state that a large injection in a patient who earlier had demonstrated a positive skin reaction, had no effect upon the patient's blood pressure.

David Turnoff
L. G. Rowntree
Philadelphia Institute for Medical Research

SCIENTIFIC BOOKS

MATHEMATICS

The Development of Mathematics. By E. T. Bell. xi+583 pp. New York: McGraw-Hill Book Co. 1940.

"Once we venture beyond the rudiments," says Mr. Bell, "we may agree that those who cultivate mathematics have more interesting things to say about it than those who merely venerate." No more eloquent substantiation of this assertion could be wished for than this book in which it appears. A cultivator himself, its author requires no introduction to mathematicians. He knows mathematical creation—its trials and its rewards—at first hand. Nor does he need introduction to the wider reading public. It seems to this reviewer, however, that in this work he has risen to a new level of accomplishment, which merits the genuine appreciation of all those who regard mathematics and its related sciences as a vital field of human activity, and find interest in the history of their development. This is an eminently readable book, written in an engaging and graceful style. At the same time it is a scholarly work with a wholly serious purpose,

[1] F. C. Bishopp, *Jour. Econ. Ent.*, 22: 974, 1929.

full of information and fact, and covering much material which is otherwise not easily accessible.

As the keynote of the book the author sounds an old quotation: "There is probably no other science which presents such different appearances to one who cultivates it and to one who does not, as mathematics. To [the noncultivator] it is ancient, venerable, and complete; a body of dry, irrefutable, unambiguous reasoning. To the mathematician, on the other hand, his science is in the purple bloom of vigorous youth, everywhere stretching out after the attainable but unattained, and full of the excitement of nascent thoughts; its logic beset with ambiguities, and its analytic processes, like Bunyan's road, have a quagmire on one side and a deep ditch on the other, and branch off into innumerable by-paths that end in a wilderness."

To the student of mathematics the historical development of his subject appears all too inevitably as a wilderness, and moreover as an almost impenetrable one when the last century or two are approached. With research pressed in this time and at the present on many fronts by a vast number of investigators, with many different groups of these pursuing apparently quite diverse objectives, and with all of them changing their tactics and goals disconcertingly often, the residue of their attainments is a weltering jungle indeed. Through this the present book lays a very welcome road. The typical and more significant trends and episodes are isolated, the genesis, growth and efflorescence of some of the concepts and methods, whose survival to the present is their guarantee of significance, are traced, and often their decadence in periods of sterile over-elaboration is observed.

The book is not of the "popular" kind, as this term is generally understood, since it makes small effort to be intelligible to readers wholly uninitiated mathematically. Indeed, its appeal will probably be found to vary almost directly with the reader's mathematical attainments. The less trained will find much that is entirely narrative and non-technical, and will sometimes find quite enlightening the concise but generally clear technical surveys that are given. The advanced student of mathematics and science will find much more to interest him, and will value the orientations which the book supplies. Professional mathematicians, even those who are themselves momentarily engaged in extending mathematical theories and their applications, will find the book a thoroughly worth-while reading of mathematical evolution. This is not to say by any means that they will in all instances read from the noted trends and related episodes precisely the same inferences as does the author. The better, perhaps, that in some cases they should not.

For the purposes of this review it is convenient to regard the book as falling into two parts, consisting respectively of the first six chapters, which treat of mathematics up to the year 1637, and the remaining seventeen chapters which terminate the discussion at the present time. The first part, which begins with a general prospectus, is given over thereafter to a review of mathematics in the ancient Babylonian and Egyptian eras, in the Greek period, in the dark age of Europe, through the Arabian epoch and the Renaissance. While completely non-technical, even these chapters are not to be regarded as a historical text. There is not the customary cataloguing of names and facts, but rather a sort of running narrative commentary, of which a full appreciation will be somewhat conditioned upon the reader's previous knowledge of the history. The author acknowledges these pages to hold in the main a collation of material from more or less familiar and classical works. This reviewer found these chapters to be by far the weaker part of the book; to be in fact a trifle pedestrian, though not always unprovocative. As is well known, iconoclastic tendencies are not invariably eschewed by this author. The so-called *debunking* of tradition is often salutary. An excess of it, however, though it adds a sensational element to the reading, may in the case of immature or otherwise undiscriminating readers leave impressions that are not wholly fortunate or just. Enjoyable or regrettable, as the reader may find them, he will find here, and throughout the book, a sprinkling of the quips and sophistications which those who know the author would rather expect, and some will perhaps deplore his occasional momentary lapses from a generally prevalent high scholarly objectiveness to the inclusion of less happy and rather discordant contemporary comment.

The peculiar contribution of the book is by all odds to be found in its second part. Here the author's excellent qualifications for his task, which include a technical equipment beyond the range of the usual historian, and a literary facility far beyond the range of the usual mathematician, really come to bear. The wide gamut of topics discussed is perhaps best suggested by the chapter headings, which are the following: The beginnings of modern mathematics 1637-1687; Extension of number; Toward mathematical structure; Arithmetic generalized; Emergence of structural analysis; Cardinal and ordinal to 1902; From intuition to absolute rigor, 1700–1900; Rational arithmetic after Fermat; Contributions from geometry; The impulse from science; From mechanics to generalized variables; Differential and difference equations; Invariance; Certain major theories of functions; Through physics to general analysis and abstractness; Uncertainties and probabilities.

It would be entirely impossible to abstract these chapters briefly. They should be read in their com-

leteness. Mathematics and mathematicians live in hem, and not infrequently lend themselves to genuine rama. The presentation of the whole is admirable. t is flowing and graceful and often characterized by a enuine and delightful humor. A feature which will e prized is the author's almost invariable practice of abelling all investigators and notable publications ith their nationality and dates.

The publishers of the book are to be thanked for an ttractive and legible volume. The author deserves ecognition and high praise for a significant and timely ork. Many the scientist who has come to realize, to is humility, that his vaunted work would in his bsence have soon been accomplished by another. One ay safely venture that no other would soon have writ-en this book had Mr. Bell not done so.

RUDOLPH E. LANGER

THE UNIVERSITY OF WISCONSIN

RADIOLOGIC PHYSICS

Radiologic Physics. By CHARLES WEYL, S. REID WARREN, JR., DALLETT B. O'NEILL. xvii + 459 pp. Springfield, Illinois: Charles C Thomas. 1941. $5.50.

THE book is divided into two parts: "(1) The theory nd practice of electrical engineering as applied to radiological apparatus. (2) The theory and application of radiation physics with reference to x-ray diagnosis and x- and gamma-ray therapy." The first part includes chapters on electric circuits; electrical measuring instruments; transformers, generators, motors nd distributing systems; electronics; electromedical apparatus. The second part deals with radiant energy; x-rays and matter; radioactivity and nuclear physics; measurement and control of x-rays and gamma rays; physical aspects of the use of x-rays for therapy, fluoroscopy and roentgenography.

The authors have adopted the analytical method in the presentation of the different subjects discussed, starting with the simplest concepts and gradually working towards the more complex ones. The book is intended as a text for students of radiology and as a reference book for the practicing radiologist and others. Exhaustive treatment of the great many topics discussed is not claimed by the authors. In general a judicious choice of the material included and details omitted has been made. There are some original and ingenious explanations of the operation of apparatus and the fundamental principles involved.

Bearing in mind that the book is intended primarily for radiologists, the desire on the part of the authors for pedantic accuracy and completeness is rather unfortunate. It conflicts with the requirement of simplicity and here and there leads to explanations which are too involved for the radiologist but too superficial for the physicist. An example of this may be found in the discussion of the standard free air ionization chamber on p. 291 *et seq.* Explanation of the operation of such items as the induction motor could have been left out to advantage. At times statements are qualified at length when a few words would have sufficed. As an illustration consider the statement on p. 320: "The quality of the γ-rays produced by a radioactive substance is independent of the amount of the substance that is used (whenever the number of atoms of radioactive material is large enough to produce γ-radiation that is continuous with time from the practical point of view)." The qualifying clause (which this reviewer has put in parenthesis) could very well have been omitted or at any rate replaced by the phrase "in radium therapy."

The disintegration constants of the uranium series on p. 262 are not the latest values, as given, for instance, in Rasetti's "Elements of Nuclear Physics." There are very few misprints. The type and paper, as well as the numerous illustrations, are excellent. The style and language are typical of the better engineering texts.

The authors are to be congratulated for the vast amount of time and effort spent in the preparation of this book, which, in spite of some shortcomings, successfully fills a gap in radiological literature. For the first time it is now possible to get a comprehensive view of the radiological armamentarium from a single volume. The book will be most useful particularly to the small, but rapidly increasing, group of physicists and engineers interested in radiologic physics.

G. FAILLA

MEMORIAL HOSPITAL,
NEW YORK, N. Y.

SPECIAL ARTICLES

CHEMISTRY OF ENERGETIC ATOMS PRODUCED BY NEUTRON CAPTURE

SOON after the discovery of the neutron production of artificial radioactivities by Fermi and his coworkers, Szilard and Chalmers[1] in England observed that a considerable part of the radioactive iodine (I^{128}) produced by irradiation of ethyl iodide with slow neutrons could be removed by the simple process of extracting with water or an aqueous solution of iodide ion. The explanation of this phenomenon was clear almost from the first. It was well known that throughout the periodic table nuclei differed in mass

[1] L. Szilard and T. A. Chalmers, *Nature*, 134: 462, 1934.

by almost integral multiples of unity rather than 1.0089, the mass of the neutron. This meant that the process of neutron capture must liberate about 0.009 mass units of energy, *i.e.*, approximately 7 to 9 millions of electron volts. Since only 2 m.e.v. on the average are evolved in the beta radioactivity following the neutron capture, the remainder of the energy is expected to appear as one or more gamma rays. This was found to be the case, the average energy being between 3 and 6 m.e.v. and indicating the occasional emission of two gamma rays in sequence rather than one of higher energy. The relativity and quantum theories together with thermodynamics require that the emission of a photon of energy E involve a momentum E/c (c is the velocity of light). From the conservation of momentum this requires that the radioactive nucleus with energy $\frac{E^2}{2Mc^2}$ where M is the mass of the atom. For example, for I^{128} this means that the recoiling atom if free would have approximately 100 electron volts energy, amply sufficient to break any chemical bond, the strongest of which are about 5 e.v.

This process is known now to occur throughout the periodic table. It is more easily observed in cases where the ejected atoms after losing their excess energy by collision are unable to interchange places with the inactive atoms bound in the mother or target molecules which generally constitute the main part of the system. For example, if instead of ethyl iodide one uses hydrogen iodide, the separation of the active atoms is nearly impossible because of an extremely rapid thermal interchange of atoms between HI and I_2 or I or I^-. As a rough general rule one finds that thermal interchanges involving truly covalent bonds are slow. This is true for most organic molecules, of course, so one is able to study in these systems the reactions which occur while the ejected radioactive atoms are moving rapidly. Table I shows that these reactions are of considerable importance. It is a tabulation of the fractions of the induced radioactivities which are retained in organic molecules for various organic halides.

TABLE I

Compound	Retention (per cent.)
C_2H_5I	40
C_2H_5Br	75
C_6H_5I	65
C_6H_5Br	70
$C_2H_4Br_2$	31

Of course one wonders whether the high retentions may not be due to some unexpected failure of the bonds to rupture as a result of the recoil. This proves not to be the case, however, for either vaporization of the target substance or dilution of it with substances all of whose atoms are of widely different mass from that of the radioactive atom result in nearly zero retentions. Table II shows retentions obtained for solutions of CBr_4 in C_2H_5OH at various concentrations.

TABLE II

Mole per cent. CBr_4	(per cent.) Retention
100	60 ± 5
1.15	28 ± 5
0.74	13 ± 3
0.45	2 ± 2
0.064	0 ± 2

Table III shows the effect of vaporization on the retentions of two halides.

TABLE III
EFFECT OF VAPORIZATION

Compound	Retention in liquid, per cent.	Retention in gas, per cent.	Pressures (mm Hg)
C_2H_5Br	75	4.5 ± .4	390 mm + 370 mm air
$H_2CBr-CBrH_2$	31	6.9 ± .6	40 mm + 720 mm air

A further point of importance is that the processes of re-entry result principally in the formation of the mother molecule. For example, in the case of liquid brombenzene a fractional distillation, after extraction with a reducing aqueous solution, has shown that within 0.5 per cent. all the activity is present as monobrombenzene, rather than in any of the dibrombenzenes or other polybrominated molecules possible. Carrier substances were added to insure that small amounts of material would have separated at the ordinary temperatures.

These facts indicate that the re-entry process consists first of a collision between a rapidly moving radioactive atom or ion and the atom in a molecule of the target substance which has one unit smaller mass than that of the impinging particle and which by absorbing a neutron would become identical with it. Because these particles have nearly equal mass and the kinetic energy of the impinging atom is larger than the energy of the bond holding the struck atom to the molecule, there is a good chance that the kinetic energy will be largely transferred to the inactive atom and the radioactive atom will be left in the debris of the collision. For example, in the case of C_2H_5I the result would be that an ethyl radical and a radioactive iodine atom would be left near each other and free to combine to reform ethyl iodide but with the iodine atom radioactive now. Since it is most improbable that the collision will leave the active atom and the organic radical with exactly the right relative velocity to allow recombination, considerable rattling around in the cavity in the liquid is usually required before recombination occurs. For this reason re-entry in the gaseous state

is greatly reduced, though a small amount should occur in the case of nearly perfect collisions.

The effect of interposing a foreign substance, such as C_2H_5OH in the case of CBr_4 none of whose atoms have masses near that of the active atom, obviously would be to slow the radioactive atom so that when it finally did make a collision with an atom of nearly its own mass it would have insufficient energy to rupture the bond in the "billiard ball" fashion described above. This of course results in nearly zero retention.

The principles outlined seem to be generally applicable. In review:

1. Retention of activity occurs mainly in the target substance.

2. Dilution with a solvent none of whose atoms are near the active atom in mass results in the limit in zero retention.

3. Retention in the gaseous state is much lower than in the liquid or solid state. The limiting retention at zero pressure is not necessarily zero, but may be a few per cent., depending on the molecule. Of course the reformed molecule is usually somewhat excited and may be able to take part in reactions which the normal molecule could not. These reactions may be used to liberate the active atom also. For example, Lu and Sugden[2] have shown that the addition of aniline to brombenzene reduces the retention very considerably, probably by the reaction

$$C_6H_5Br^* + C_6H_5NH_2 = Br^{*}_{-} + (C_6H_5)_2\overset{+}{N}H_2$$

resulting in the liberation of the active bromine atom.

W. F. LIBBY

UNIVERSITY OF CALIFORNIA,
BERKELEY

THE EFFECT OF HEAT ON CRYSTALS OF SERUM ALBUMIN; PRODUCTION OF CRYSTALS OF DENATURED PROTEIN

A STUDY of the effects of heat on crystals of serum albumin has led to some curious and unexpected results. That heat denatures proteins is well known, and many investigations have been made on the heat denaturation of protein *solutions*. For a study of heat denaturation of proteins *in the crystalline state* horse serum albumin is a suitable protein because crystals of this protein do not tend to dissolve when the temperature rises, as crystals of egg albumin, for example, do. On the contrary, under certain conditions, warming a solution of horse serum albumin increases the rate of crystallization. If 0.5 ml of serum albumin solution (containing 50 mg of protein, previously crystallized, but not fractionated and subsequently dialyzed free of salt and then filtered) is added to 12 ml of a sodium sulfate-acetate solution (made by mixing 10 ml of 23 per cent. sodium sulfate with 1 ml of 2 M sodium acetate and 1 ml of 2 M acetic acid), crystallization begins in less than 5 minutes if the solution is warmed to 45° C., and within 15 minutes there appears a plentiful crop of large well-formed, needle-shaped crystals. At 25° crystallization proceeds much more slowly. These crystals dissolve at once if 12 ml of water are added. Heating the original solution of serum albumin in sodium sulfate-acetate to 60°, instead of 45°, causes a large flocculent precipitate of protein to appear almost at once. This precipitate is amorphous and, if heating at 60° is continued for 15 minutes, practically no protein dissolves when the suspension is subsequently cooled to room temperature and 12 ml of water are added. At 60° the amorphous protein precipitate obtained is obviously denatured.

At this point it seemed of interest to inquire what would happen to crystals of serum albumin if they were heated to 60° and still higher temperatures. For this purpose crystallization at 45° was allowed to proceed for several hours. The crystals were separated by centrifuging from the small amount of albumin still remaining in solution, and to the crystals was added the original volume of sodium sulfate-acetate mixture at 45°. In this medium the protein crystals were heated at various temperatures from 60° to 100° and finally in an autoclave at 115°, at each temperature for 15 minutes. At no temperature were the crystals destroyed. Even after heating at 115° the crystals seemed as perfectly formed as before heating.

The solubility of the heated albumin crystals was tested at room temperatures by adding to each heated preparation 2 volumes of water. The crystals heated at 60° dissolved in the course of five or ten minutes. Since heating a *solution* of serum albumin under the same conditions renders the albumin insoluble, it is clear that the protein in the crystal is not as easily denatured as is dissolved protein. If protein denaturation is an unfolding process, as there is good reason to believe,[1] then the increased stability of the protein in a crystal may be explained by supposing that the tendency of a molecule to unfold as the temperature is raised is opposed by the bolstering effect of neighboring molecules in the crystal.

Crystals of serum albumin heated at temperatures higher than 60° did not dissolve completely. A small percentage of those heated at 70° dissolved, but practically none of the crystals heated between 80° and 115° dissolved even after standing, with occasional stirring, for three days. These albumin crystals were not destroyed by being placed for several days in 1 N HCl or 95 per cent. alcohol. They dissolved at once, however, in a saturated urea solution. The insoluble serum albumin crystals are as insoluble as a heat-denatured, amorphous coagulum of serum albumin.

[2] C. S. Lu and S. Sugden, *Jour. Chem. Soc.*, 1273, 1939.

[3] W. F. Libby, *Jour. Am. Chem. Soc.*, 62: 1930, 1940. This paper contains numerous other references of importance.

[1] A. E. Mirsky and L. Pauling, *Proc. Nat. Acad. Sci.*, 22: 439, 1936.

One hesitates, however, to compare the heated crystals with a heat denatured protein because, despite many efforts, no denatured protein has been crystallized. And yet it can be shown that the heated, insoluble crystals are indeed crystals of denatured protein. The crystals, washed free of sodium sulfate by repeated centrifugation, readily dissolve in a pH 9.2 borate buffer. Crystals prepared from 0.3 ml of the serum albumin preparation mentioned above can be dissolved in 0.4 ml of a 0.1 M pH 9.2 borate buffer. If to this solution at 45° are added 5 ml of the sodium sulfate-acetate mixture used for crystallizing serum albumin, no crystals form. Instead all the protein immediately precipitates amorphously, and this precipitate does not dissolve when the salt solution is diluted with an equal volume of water. The albumin dissolved by placing crystals previously heated at 80° in the pH 9.2 borate buffer has the characteristic properties of a denatured protein. Denaturation is not caused by the pH 9.2 buffer, for if this buffer is added to native, unheated serum albumin, there is no difficulty in crystallizing the albumin and subsequently dissolving the crystals in water.

It is clear, then, that the heated crystals of serum albumin that are insoluble in water are crystals of denatured protein. Denaturation does not destroy the crystal pattern (although crystallographic analysis will probably show that it has been changed) but once the denatured albumin molecules are released from their confinement within the crystal by being dissolved in a pH 9.2 buffer it is impossible to replace them in the ordered pattern characteristic of a crystal of native protein. It is possible to obtain crystals of denatured protein by denaturing a protein while it is in the crystalline state, but it does not seem to be possible to crystallize a denatured protein.

A. E. MIRSKY

THE HOSPITAL OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

N^1-(β-AMINOETHYL)SULFANILAMIDE AND N^1-(β-DIETHYLAMINOETHYL) SULFANILAMIDE

THESE compounds were prepared from monoacetylethylenediamine[1] and β-diethylaminoethylamine,[2] respectively. The amine in an aqueous solution containing 1.5 molecular proportions of sodium bicarbonate was shaken for five hours (ten hours for the second compound) with a chloroform solution of 1.2 molecular proportions of acetylsulfanilyl chloride.[3] The insoluble material was separated by filtration (in the case of the second compound, after evaporating off most of the water and chloroform) and was hydrolyzed by boiling with 6 normal hydrochloric acid (8 cc per gram of the precipitate; in the case of the second compound, 4 cc per gram of the precipitate) under a reflux condenser for twelve hours. The compounds were isolated as the dihydrochlorides by evaporation of the solutions to dryness with a current of warm air and were purified by crystallization from ethyl alcohol-water mixtures (85 per cent. alcohol for the first compound; 95 per cent. for the second).

N^1-(β-Aminoethyl)sulfanilamide dihydrochloride. Yield (based on monoacetylethylenediamine): 90 per cent. Calculated for $C_8H_{15}O_2N_3SCl_2$: N, 14.58 per cent.; Cl, 24.61 per cent. Found: N, 14.37; Cl, 24.04. M.p. 217–220°[4].

N^1-(β-Diethylaminoethyl) sulfanilamide dihydrochloride. Yield (based on β-diethylaminoethylamine): 30 to 65 per cent. Calculated for $C_{12}H_{23}O_2N_3SCl_2$: N, 12.20 per cent.; Cl, 20.60 per cent. Found: N, 12.03; Cl, 20.59. M.p. 190–195°[4].

The synthesis of additional N^1-(β-dialkylaminoethyl) sulfanilamides is in progress. These compounds will be tested for chemotherapeutic activity.

LAWRENCE H. AMUNDSEN
LENA A. MALENTACCHI

UNIVERSITY OF CONNECTICUT

[1] Prepared by the method of Arthur J. Hill and Samuel R. Aspinall, *Jour. Am. Chem. Soc.*, 61: 822–5, 1939.

[2] Prepared as described by Lawrence H. Amundsen and Karl W. Krantz, *Jour. Am. Chem. Soc.*, 63: 305–7, 1941.

[3] Prepared by the method of S. Smiles and Jessie Stewart, "Organic Syntheses," collective vol. 1, edited by Henry Gilman, pp. 8–9. New York: John Wiley and Sons, 1932.

[4] Melting point ranges were somewhat indefinite. The compounds seemed to be undergoing decomposition, as gas appeared to be evolved.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ANOTHER CIRCUIT FOR TEMPERATURE CONTROLS

NUMEROUS articles have appeared in the literature recently describing circuits intended for use with thermostatic devices to control closely the temperature of ovens and chambers used for biological and chemical processes. Two of these have appeared within the last three months in SCIENCE.[1,2]

Most of the circuits so far described require the use of one or more thermionic tubes to amplify the current passing through the control device. This greatly amplified current is caused to operate a commercial relay. The satisfactory use of these tubes often involves the use of transformers, condensers and numerous resistances. Occasionally it has been found that changes in atmospheric conditions alter the values of

[1] A. C. Hall and L. J. Heidt, SCIENCE, 92: 2380, 133, August 9, 1940 and SCIENCE, 92: 2400, 612, December 27, 1940.

[2] Charles Butt, SCIENCE, 92: 2389, 339, October 11, 1940.

grid leaks sufficiently to cause failure of operation. The use of improved high resistances now on the market may overcome this objection. It is obvious that a satisfactory arrangement which would operate a relay directly from the control device would greatly simplify the circuit and reduce the amount of equipment necessary.

The writer has had occasion within the past several years to accurately control temperature by using a mercurial thermometer into which platinum contact wires have been placed. When used with the ordinary relay and without an auxiliary circuit, the surface of the mercury is soon contaminated and separation of the column results. Thermionic tubes, as suggested by the papers to which reference has previously been made, eliminate this difficulty, but complicate the circuit and some technical supervision and maintenance are necessary.

A circuit has been developed which appears just as satisfactory and somewhat cheaper and easier to assemble. This circuit is shown in Fig. 1. The relay is

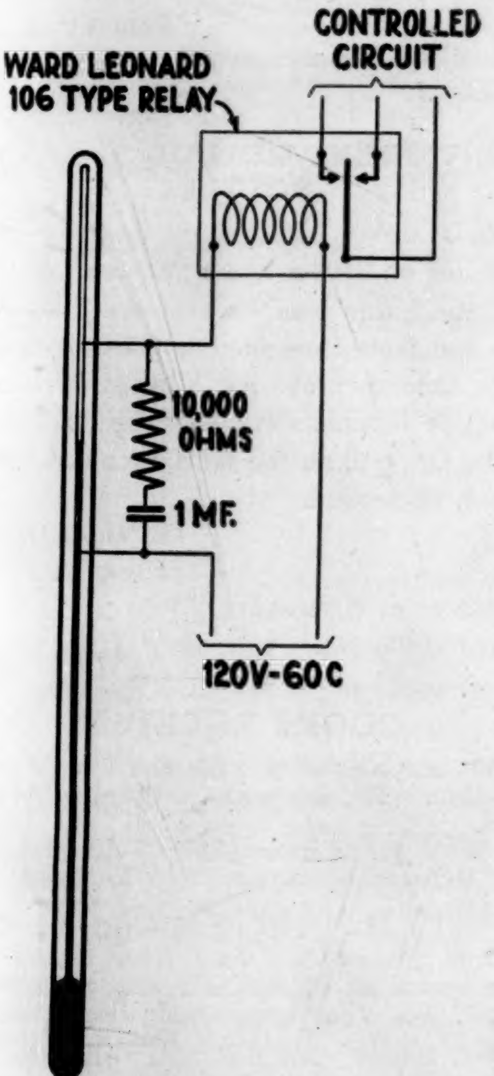

FIG. 1.

connected to the thermometer in the usual way, and in addition an auxiliary circuit, consisting of 10,000 ohms resistance in series with a one microfarad condenser, is placed across the terminals of the thermometer. This circuit absorbs the inductive energy stored in the magnetic field of the relay at the instant when the circuit is broken. The value of the constants given above applies only to the Ward-Leonard 106-662 type relay (120 volts), although many other relays would no doubt perform equally satisfactorily were the proper values for resistance and capacity determined. The type 106-662 was chosen for study because it is a double throw, double pole relay and thus is quite flexible.

The values of the resistance and the capacity are not critical, but should be held to within plus 5 per cent. The use of an electrolytic condenser is to be avoided. A telephone condenser manufactured by the Stromberg Carlson Company has been found most satisfactory. Suitable resistance may be purchased at any radio store for about ten cents. Observation of the mercury column at the time of make and break showed no spark in the thermometer tube, even though the tube was observed through a microscope and in a dark room. Sparking was very noticeable when the auxiliary circuit was not connected.

Attention is called to the fact that this circuit may be used only on 120 volts 60 cycles, A.C. Direct current might be used with a suitable relay, if sufficient capacity were installed, and in this case the resistance may be eliminated. Attempt has been made to find a suitable combination for use with 24 volts A.C., but thus far without success. It seems strange that it is possible to break 120 volts successfully and not be able to accomplish the same result on 24 volts, but it should be remembered that the 24-volt relay necessarily requires more current to operate than does a relay of higher voltage. The energy in the magnetic field is proportional to the square of the current. All visible sparks may be eliminated on the 120-volt break, but this condition has not been attained at the lower voltage.

Life of the thermometer depends on several factors and decreases rapidly as the size of the spark increases. The contamination mentioned above may be the result of amalgamation or chemical action of the mercury, or may be the result of a sputtering of the platinum. It is a well-known fact that mercury will amalgamate with platinum at temperatures of 200° C. and above. Any visible spark probably indicates a local temperature of 4,000° C. so that an actual melting and vaporization of a small amount of platinum is not without the realms of possibility. It may also be that the lead oxide in the glass reacts with either mercury or platinum at the elevated temperature of the arc.

Fortunately, it is not necessary to know the exact causes of the contamination in order to completely

eliminate the difficulty. Thermometers properly made and used with the above circuit have a life far exceeding that of the relay. In fact, the writer has three thermometers which have made over 14,000,000 operations each, without failure, and continue to function perfectly. The original relays have been replaced. Much depends upon the proper design and construction of the thermometer.

The question often arises as to how accurately the temperature of a bath or oven may be controlled by an instrument of this type. Unfortunately, there is no simple answer. Too many factors must be considered, such as the time lag of the bath, its heat capacity and the manner of supplying energy. Suffice it to say, that for close control, lag of the bath should be as small as possible. Good thermal insulation is essential. Forced circulation is necessary; and finally, the energy should be supplied (or withdrawn) at as constant a rate as practical. "On" and "off" circuits are not desirable.

To illustrate, let it be assumed that a bath is to be held at 200° F. Assume that 200 watts is not sufficient to maintain this temperature, even when the environmental temperature is a maximum, and that 300 watts is more than enough to maintain the desired 200° F. temperature even when the external temperature is a minimum. The relay should control only the difference of 100 watts, 200 watts being supplied to the bath at all times.

A simple method of accomplishing this is to place a resistance of suitable size in series with the heating element, allowing 200 watts to pass to the bath at all times. The relay should be connected so that when the temperature of the bath is as high, or above the control temperature, the contact of the thermometer is closed and the resistance is in the circuit. When the bath is too cool and the contact through the thermometer is broken, the relay contacts short the resistance and energy supply to the bath is increased to the 300 watts. Such circuits are easily designed, particularly if a variable transformer such as the Variac, manufactured by the General Radio Company, is available.

The other factors mentioned are beyond the scope of this article.

BRADFORD NOYES

ROCHESTER, N. Y.

ANOTHER METHOD FOR RECORDING LOCALITIES FROM TOPOGRAPHICAL MAPS

THE method of indicating localities from topographical maps suggested by Clyde F. Reed[1] has certain disadvantages. Not only must one construct an elaborate grid in order to record the localities, but any one wishing to interpret the record must also construct a similar grid. Since topographical maps are now printed in two sizes, both the recorder and the interpreter must have two grids.

A much simpler method, and one which could be used on any map regardless of size or latitude, would be to use the lower left-hand corner of the map as origin, recording in centimeters the distances of the locality from the left-hand margin and the lower margin of the map. Decimals may be used if great accuracy is necessary. As an example, the summit of Taum Sauk Mountain, the highest point in Missouri, would be recorded as: "Edgehill (31.0, 12.4)." This method has the advantage of conforming with ordinary graphing methods.

If it is desired to cut the map in segments for convenience in the field it is only necessary to indicate on the margin of these segments the distances to the margin of the complete map and to add these to the measurements on the segment.

LESLIE HUBRICHT
RALPH O. ERICKSON

MISSOURI BOTANICAL GARDEN,
ST. LOUIS

[1] SCIENCE, 93: 68.

A CONVENIENT METHOD OF LABELING BOTTLES

IF labels are typewritten on ordinary paper and then applied on bottles under "Scotch cellulose transparent tape," they can be removed readily without soaking and placed on another bottle if desired. At the same time they are not affected by dilute acids, alkali, oil or organic solvents. The transparent tape should be larger than the label by about one quarter of an inch all around.

CHARLES GURCHOT
JACK K. FINNEGAN

UNIVERSITY OF CALIFORNIA,
SAN FRANCISCO

BOOKS RECEIVED

Carnegie Institution of Washington Year Book No. 39, 1939–1940. Pp. xxxi + 326. The Institution, Washington.

RIDER, JOHN F. *Vacuum Tube Voltmeters.* Pp. xi + 179. Illustrated. Author, New York. $1.50.

RUHEMANN, M. *The Separation of Gases.* Pp. xiii + 283. 148 figures. Oxford University Press. $5.75.

SLAUGHTER, FRANK G. *That None Should Die.* (A medical novel.) Pp. 423. Doubleday, Doran. $2.75.

SOHON, F. W. *The Stereographic Projection.* Pp. ix + 210. 53 figures, 1 plate. Chemical Publishing Co. $4.00.

Tôhoku Imperial University, Science Reports. First Series. (Mathematics, Physics and Chemistry.) Vol. XXIX, No. 3. Pp. 315–469. Illustrated. Maruzen, Tokyo.

VOSBURGH, WARREN C. *An Introduction to Quantitative Chemical Analysis.* Pp. viii + 356. 27 figures. Holt. $2.75.